Ingredients to Move Mountains

By GERALD MEYER, ENGR. II

Explosives is a devastating word! It is usually connected with whole city blocks torn asunder; hospitals and churches lying in veritable ruins; huge gaping holes in the walls of school buildings and libraries; peaceful villages levelled to the ground; farm land covered with yawning craters; shadowy hulks settling to the ocean floor; vast steel skeletons crumpling into rivers—but do you know how explosives are prepared and how they compare in physical and chemical properties?

The word explosive is derived from the Latin verb **"explodere"** meaning to drive out or to drive out with clapping. Explosives are substitutes which easily react at comparatively low temperatures with the formation of a considerable volume of highly expanded gas, the evolution of heat and light, and the production of sound. Under standard conditions of temperature and pressure they may be solid bodies like gunpowder, liquid like nitroglycerin, or gaseous like fire damp mixtures. They may consist wholly of a single chemical compound like mercuric fulminate, or mixtures of combustible substances with supporters of comtion or oxidizing agents like blasting powder, which is a mixture of charcoal sulfur, and sodium nitrate.

This article will deal with the preparation of three distinct types of explosives generally known as gunpowder, guncotton, and mercuric fulminate. Their characteristic differences in sensitivity and explosive power also will be discussed.

Testing Instruments

There are two instruments of immense value in determining the differences in sensitivity and explosive powder of explosives. The first of these is a simple device to record the sensitivity of an explosive substance. It consists of a perfectly flat square of steel with a rod rising from each corner perpendicular to the plane of the base. These rods ascend four feet into the air and are connected together by welded steel strips. Inside this rectangular prism is another square of steel weighing two kilograms with a rod fitted through each of its corners, leaving it free to ascend or descend with little loss of motion. A small rope is attached to this plate and is extended through the top of the prism. The lower surface of this block is flat and parallel to the surface of the base. One of the rods is graduated in centimeters and half centimeters. The two kilogram weight is raised and dropped on the explosive. The height to which it must be raised to cause the explosive to "fire" is a measure of detcnating powder required to set off the explosive. This is the mechanical shock instrument.

The Trauzl lead block is used for determining the explosive power of a substance. This is a block about 20 centimeters square made of chemically pure, soft lead with a hole bored in the middle 15 centimeters deep and 25 millimeters in diameter. The explosive is packed in the cavity of the block and a fuse is attached. The increase in the cavity of the block is a measure of the explosive power. Although this instrument does not give exact results, it is accurate enough to serve the purpose of comparing the explosive power of certain types of explosives.

Gunpowder

Probably the best known of all explosive substances is gunpowder. It has been utilized by man for centuries as a propellant, and even centuries before that, was employed in the making of fireworks. Gunpowder is very easily produced in the laboratory since it is a mechanical mixture. It consists wholly of nitre (potassium nitrate), sulfur, and charcoal. Quite some care should be taken in the selection of these materials to insure a gunpowder with a high efficiency. The nitre should be near chemical purity, have no action on litmus, and be quite free from the chlorate and perchlorate of potassium. It should contain very little chloride as it will become deliquescent. The sulfur used must contain no sulfuric acid as it will react with the nitre. For this reason roll sulfur is used and ground down. The charcoal should be of the finest quality containing no impurities, since the quality of the gunpowder depends greatly upon it.

Great care should be taken in the preparation of gunpowder that the friction of grinding does not raise the temperature of the mixture to its kindling point.

Gunpowder consists of 75 parts by weight of nitre, 15 parts by weight of charcoal, and 10 parts by weight of sulfur intimately ground together, in a mortar until they form a finely divided uniform mixture. This mixture must not come in contact with moisture, as gunpowder that has become damp and then dried loses some of its power. Sodium nitrate is being widely used in

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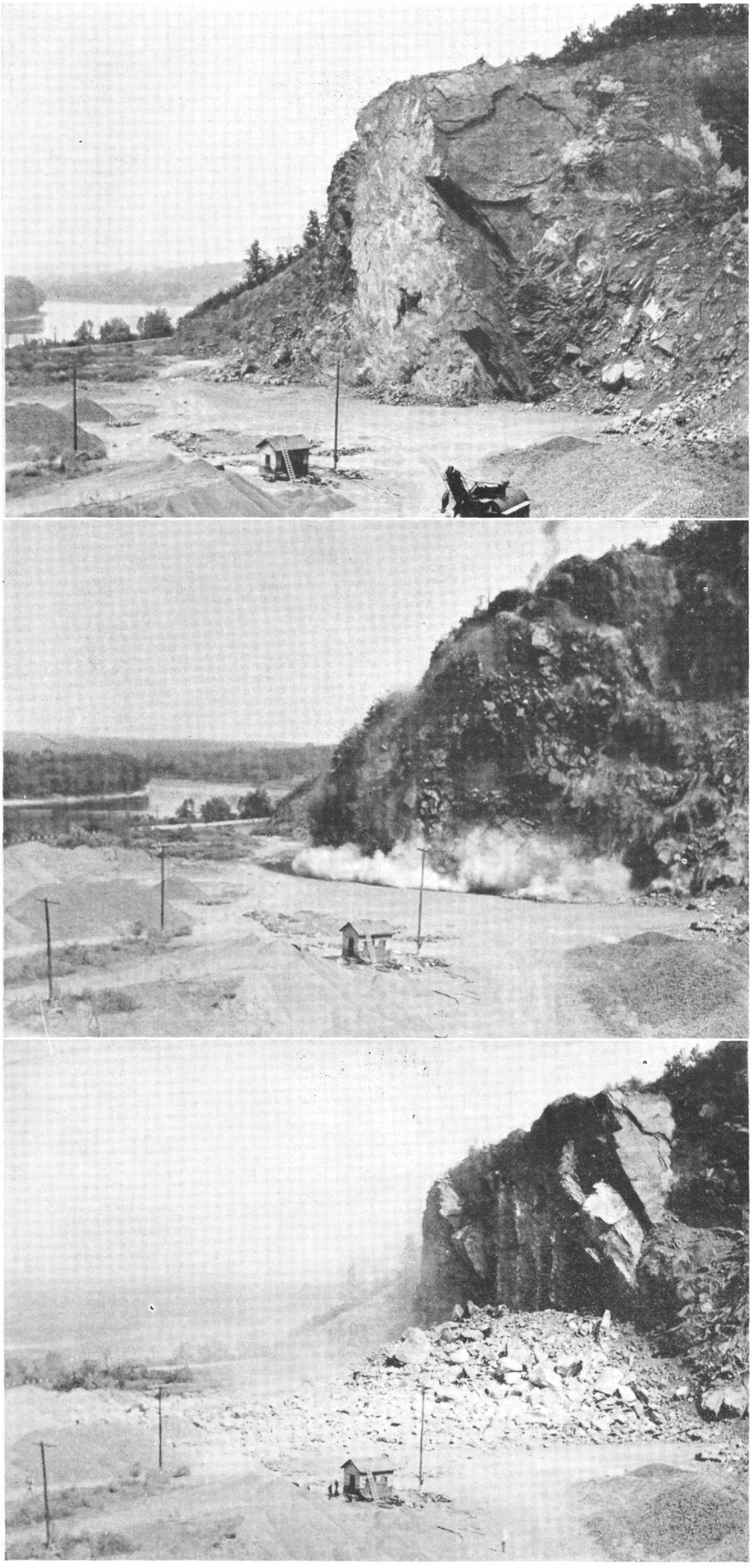
Saved! Tons of tin!

For years telephone cables have been spliced in a very satisfactory way. But the solder joint contained 40 per cent war-vital tin.

So Bell System men devised a new type of joint which saves up to 80 per cent of the solder. A "Victory Joint" they called it.

The new technique has been adopted throughout the System with the result that 600,000 pounds of tin and an even greater amount of lead can be saved in a normal year's construction.

This is another example of the nation-wide cooperation of Bell System people in fulfilling their ideal —service to the nation in peace or war.



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place of potassium nitrate in gunpowder because of its lower cost and the added power it imparts to the mixture. Care must be taken, however, in its manufacture and storage because of its hygroscopic properties.

If a one gram sample of the gunpowder is placed upon the steel base of the mechanical shock machine, it will be found that the shortest drop of the two kilogram weight which will explode the mixture is about 70 centimeters. This varies somewhat with each mixture and very noticeably if sodium nitrate is used instead of nitre or if the components contain many foreign substances.

A ten gram weight of gunpowder packed tightly in one gram of tin foil with a fuse projecting from one end and placed in the bore of the Trauzl lead block will enlarge the cavity of the block 100 cubic centimeters when exploded. This test must take place with the explosive covered by finely divided sand so as to utilize the full explosive power of the substance.

Guncotton

Guncotton is a nitrocellulose compound used chiefly as a propellant in small arms. In its storage it should be kept free from water, otherwise it will lose some of its energy. Cotton waste is employed in the preparation of guncotton, but it must first be thoroughly cleaned and washed to remove oil. The acid used in the reaction is approximately twenty-five per cent nitric acid and seventy per cent sulphuric acid in solution with water. The waste cotton is dipped in this mixed acid and allowed to remain for five minutes. It is then wrung out and placed in water cooled containers for nitration to take place. After several hours the excess acid must again be wrung out and the cotton plunged into a bath of cold water. If the resulting substance is insoluble in an alcohol and ether mixture, it is guncotton; otherwise the nitrating process much be continued until the correct results are obtained.

The weight on the mechanical shock machine must be dropped ten centimeters to explode the guncotton after it has been dried. The test with the Trauzl block shows a cavity of nearly three hundred cubic centimeters when the substance is exploded.

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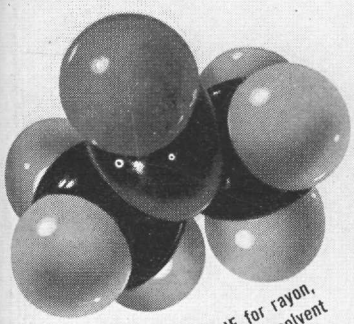
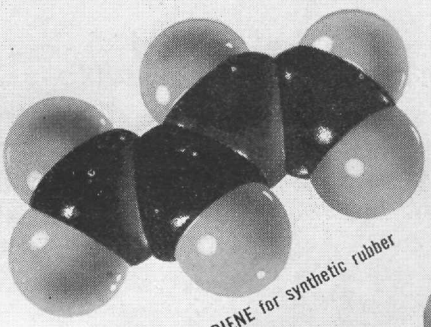
● Successive stages of disintegration by blasting.

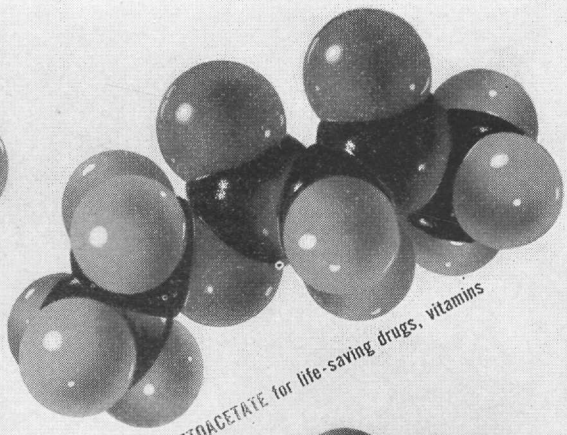
Courtesy Explosive Engineer



ACETONE for rayon, photo film, solvent



BUTADIENE for synthetic rubber



ETHYL ACETOACETATE for life-saving drugs, vitamins

Molecular Keys To A New World

VAST NEW SOURCES of raw materials . . . the equivalent of those which might be found in a great new continent . . . opened to America when CARBIDE AND CARBON CHEMICALS CORPORATION, a Unit of UCC, started building synthetic chemicals from water, salt, air, and hydrocarbons.

These chemicals are usually water-white liquids, although some are gases or solids. Basically, they are compounds of carbon and hydrogen—united with oxygen or with chlorine to build up an endless series of chemicals. The models of those molecules of chemicals shown here are many millions of times actual size.

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Since these chemical wonders are obtained from abundant domestic sources, their use has contributed materially to the nation's self-sufficiency. Through research, American ingenuity, and patient development, scarce natural products have been duplicated or improved upon. Great new industries and great new materials that contribute to the nation's strength have come into being. And America has become a leader in a field as native as its own soil.

Broadly speaking, the uses of many of the synthetic organic chemicals developed by CARBIDE AND CARBON CHEMICALS CORPORATION are just beginning. The already established uses are indicative of their vast future values to mankind.

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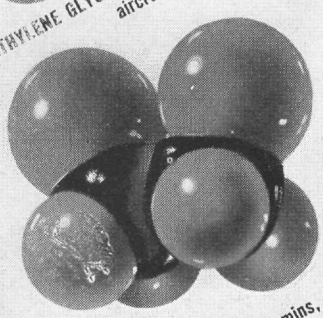
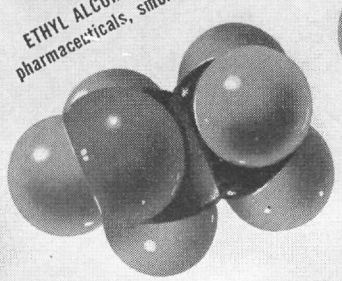
ETHYLENE GLYCOL for dynamite, anti-freeze, aircraft engine coolant

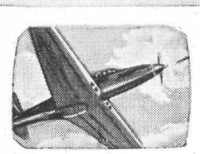


ETHYL ALCOHOL for lacquers, pharmaceuticals, smokeless powder

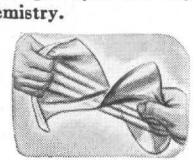


ETHYLENE DICHLORIDE for vitamins, anti-knock fluid, plastics, insecticides

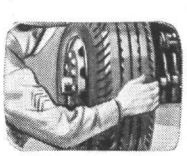
BETTER MEDICINES! Amazing medicines like the sulfa drugs, synthetic vitamins, powerful insect repellents, and anti-malarial drugs depend upon synthetic organic chemistry.



COLD PROOF! Coolant for liquid-cooled aircraft engines and base for anti-freeze in military cars and trucks is ethylene glycol, an important synthetic chemical.



MAGIC PLASTICS! Wonderful plastics that look like glass, stretch like rubber, and which are proof against water, sunlight, oils, and many chemicals are made from VINYLITE synthetic resins.



MAN-MADE! All types of synthetic rubber require synthetic organic chemicals for their manufacture. Here's hope for tires for you in the future.

UNION CARBIDE AND CARBON CORPORATION

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INDUSTRIAL GASES AND CARBIDE
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The Oxweld Railroad Service Company
The Prest-O-Lite Company, Inc.

PLASTICS
Bakelite Corporation
Plastics Division of Carbide and Carbon Chemicals Corporation

INGREDIENTS TO MOVE MOUNTAINS

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Mercuric Fulminate

Mercuric fulminate is in almost universal use as a detonator for blasting charges because of its rapid acceleration and the fact that it is not unduly dangerous to handle when proper precautions are taken. Nevertheless, it is expensive and does not keep well and for this reason lead azide is coming into more general use.

Mercuric fulminate is prepared by dissolving five grams of mercury in 45 grams of nitric acid. The solution of mercuric nitrate thus obtained is cooled to room temperature, and 50 milliliters of 95 per cent ethanol (ethyl alcohol) are added. After the reaction has subsided, the mercuric fulminate should be cooled and thoroughly washed in cold water. It must then be filtered from the solution and kept moist until just preceeding its use. All during the reaction an ample draft must be provided to draw off the fumes, as they are very poisonous.

Mercuric fulminate can be exploded by dropping the two kilogram weight of the mechanical shock machine just two centimeters. Its explosion in the Trauzl lead block displays a cavity of approximately two hundred and seventy-five cubic centimeters.

Comparison of Explosives

From these tests it has been shown that the sensitivity of an explosive and the force of its explosion is considerably less in a mechanical mixture than in an explosive in which the combustion takes place completely within the molecule. The kinetic energy of an explosive substance is also contingent upon its deliquescent properties and the chemical purity of its constituents. To prepare an explosive with a high efficiency, only the purest substances available should be used.